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Abstract

Current work environments and IT advances provide managers with a wealth of information stored in internal, external databases and data warehouses. Managers often mention the fact that they are overloaded with the amount of information that they receive, or more precisely that they cannot cope with this overload: therefore, a critical issue for designing decision and management support systems has become to extract and present the information in a timely and usable manner. In a research project, we look at how we can make the work of managers more productive from the Fragmentation of Working Time (FWT) perspective in 6 small and medium-sized companies. One of the solutions that we have adopted is a collection of push technology-based tools, which support the manager in decision-making situations. This paper presents the FWT framework which guides our work, the approach that we have used to integrate push technology in the DSS framework, the tools which have been developed in one case company in the context of Internal Logistics and Material Flow Control processes, and results on the impacts on the manager's productivity.

1. Introduction

Current work environments and IT advances provide managers with a wealth of information stored in internal, external databases and data warehouses. Managers often mention the fact that they are overloaded with the amount of information that they receive, or more precisely that they cannot cope with this overload: therefore, a critical issue for designing decision and management support systems has become to extract and present the information in a timely and usable manner. New technology advances enable us to deal with these problems: intelligent agents, data warehouse, Web and push technologies can be implemented to improve managerial decision support, especially in data-rich environments, where relevance, exactitude and timeliness matter. In a research project, we look at how we can make the work of managers more productive from the Fragmentation of Working Time (FWT) perspective in 6 small and medium-sized companies. One of the solutions that we have adopted is a collection of push technology-based tools, which support the manager in decision-making situations. This paper presents the FWT framework which guides our work, the approach that we have used to integrate push technology in the DSS framework, the tools which have been developed in one case company in the context of Internal Logistics and Material Flow Control processes, and results on the impacts on the manager's productivity.

2. Fragmentation of Working Time

In the SMARTER research project, we look at the effects and causes of Fragmentation of Working Time and ways to cope with it. Action research is used as a methodology to identify problems and find IT-based solutions related to our research problem, jointly with 6 case companies. The resulting actions and solutions include an Action programme for FWT and a collection of IT-based tools for coping with specific FWT-related problems and improve productivity. In this section, we introduce more precisely the underlying concepts of the FWT problem, and the solutions that we propose.

2.1 Fragmentation of Working Time defined

We have defined FWT as "The whole of effects and consequences on personal and organizational productivity resulting from interrupted work environments, which are generated by (i) interruptions, (ii) work process discrepancies and (iii) inefficient information technology support"(Tétard, 1999, 2000).

We argue that the effects of the reasons, which we mention in the above definition, are inflated by the following factors:

- <u>Information overload</u>: managers' efficiency has been limited by lack of quality and up-to-date information; now, thanks to IT developments, information barriers have been removed and organisation's information flows have grown: nowadays, our managers appear to be in such a position that they receive more information than they can actually process (Speier et al, 1999; Shenk, 1997).
- <u>The network and lean organisations</u>: Small and medium-sized firms are subject to strong competitive pressures which lead them to look for cost-effectiveness and trim their organisation. Combined with the emergence of new organisational models (network and lean organisations), it has the effect of involving key people in too many activities. Also, management of one's own time depends on other

people. Especially the working time of key people of the organisation is consumed by daily routines, and they hardly find the necessary time to focus on their core activities, at which they are good, and to use their skills at their full potential. Involving people in many teams, which is good in a sense since it promotes teamwork and knowledge-sharing, has the vicious effect to increase the need for information and knowledge, as people feel the need to be always informed about anything that is going on in the projects where they are involved (Champy, 1998; Coolidge, 1999; Filipowski, 1991).

- Information Technology: The use of IT is increasing at a tremendous rate in any organisation and especially in managerial work. It often occurs that IT solutions are mixed or outdated: as a consequence, it becomes difficult to transfer information, it slows down the workflow and affects one's and other people's work schedule. Mobile technology also has the effect to unconsciously and unintentionally increase workload and stress. Introduction of new technology can also translate into periods of adjustments: any new technology has to be assimilated before it can be used at its full potential. The use of different software applications and their increasing complexity can cause frustration for the managers, if these are not trained properly.
- The changing nature of work***:*** Work has changed from divided, individualized, specialized and monitored work to integrated, team-based, multifunctional and self-coordinated work (Drucker, 1988; Osterman, 1990). These new properties of work indicate that it is becoming more knowledge-intensive in the sense that the worker needs to understand the business across functional areas of the organisation. This has been commonly called knowledge work: product development, project management and system development are some examples (Davenport, 1996). Knowledge work activities are primarily subject to the problem of FWT that we are talking about, because the nature of knowledge work is such that it requires some flexibility to be performed in optimal conditions, this flexibility can be a trap leading to fragmented working time.

2.2 An action programme for FWT

In order to act on FWT in our case companies, we have designed an Action Programme for FWT. This programme combines a set of methods to act on FWT from 2 main perspectives: we have classified these into proactive and reactive methods:

- Proactive methods: we try to reduce the number of undesired interruptions before they take place. This can be done with: (1) *collective and individual time management*: we encourage people to avoid unnecessary interruptions, to choose appropriate communications channels, to set up rules to sort out undesired interruptions, (2) *training*: we train managers to use IS tools more effectively (office management software, e-mail programs, …), (3) *better design of IS tools*: avoid e-mail notification features (or better control of this feature), better system interfaces for the user, (4) *workflow analysis and reengineering*: look for interruptions which are caused by inappropriate workflow and attempts to redesign the workflow according to our objectives.
- Reactive methods: when we are not able to prevent interruptions to take place, we try to reduce the negative effects of interruptions. In order to accomplish this, we can (1) *provide workers with tools to cope efficiently with interruptions*: this category expresses the need for Support Information Systems (Decision Support Systems, Knowledge-based Systems) which provide information needed to handle the interruptions, (2) *design work environments to help reducing negative effects*: improve the design of system interfaces.

3. Push-technology for decision support

3.1. Push technology: definition and trends

The “Push” concept emerged as a reaction to information overload. It can reduce the burden of acquiring data from various data sources, especially for information-intensive tasks where timeliness and accuracy of information are crucial issues. The Push concept introduced a new approach to information retrieval and scanning compared to the traditional pull approach, where the user has to identify and know the location of the data source in order to be able to extract data. Push differs in the sense that the server will scan determined data sources and push the information to the client, as soon as it is updated or on a scheduled basis. The earliest form of push technology was electronic mail; recent technology forms include channels integrated in Web-browsers, filters, notificators and information dispensers.

A myriad of push technology products have flourished on the Internet in the last 5 years (Strom, 1997, 1999), and many of them have vanished rapidly, leading to think that the push technology adventure was a fad which would end soon[1]. Push products were mainly criticized for their high bandwidth consumption, and for diverting attention from what really matters[2]. Push products (and users) have

[1] Most of the products targeted business customers who browse for international, finance and business news.

[2] Push technology actually seemed to increase information overload by providing a lot of data through various fancy application interfaces (screensavers, Web-

suffered from a lack of standards in information presentation and a lack of means to use and exploit the information. The recent trends in push technology development are to deflate the volume of information and to present the information in standard formats which can be used in e-mail clients, (for example in Strom, 1998); another trend is that technology vendors are implementing push products which are more tightly integrated with organizations' business processes and internal databases.

Push technology can be classified in many different ways: we present here a few classifications (derived from De Marco et al, 1999), which we will use further when seeing how to apply push technology in the DSS framework.

- Target audience: is the product addressed to business or consumer audiences?
- Content delivered: push technology allows to deliver a wide range of contents, including simple notifications, messages, articles, multimedia content and also software applications.
- Update frequency: pure push technology updates the content as soon as it has changed in the data source, but most products offer update scheduling options.
- Usability of the content: can the content be used further for task completion?
- Intelligence of the search and the presentation processes.

3.2. Push technology as a component of the DSS framework.

There is little material referring to implementations of push technology to decision support. De Marco et al investigated application areas of push technology for management and decision support, concluding that push technology actually fits the wider framework of Management Support Systems[3] (MSS, see Turban and Aronson, 1998) rather than the DSS framework for the following reasons: (i) push applications cannot be considered as model-oriented systems but rather as data-oriented (-intensive) systems, (ii) push technology does not provide specific data models or structures, (iii) lack of interactivity between the user and the system, (iv) multidimensional scalability.

Although there is no universally accepted definition of what a DSS is, and as this discussion is beyond the scope of this paper, we identify some common aspects from the DSS literature and show how push technology fits. We propose to use the Decision Support Framework, introduced by Scott Morton (Gorry and Scott Morton, 1971), and shown as a simplified version in Figure 1. Considering this framework, we suggest and want to demonstrate with our case that Push technology can be applied to situations where decisions are rather or highly structured (the upper part of the figure). These decisions are repetitive and, in most of the cases, there are models available for taking decisions; also the data used for these decisions often originate from corporate databases or known data sources and is updated on a regular basis. Also semi-structured decisions can be seen as an application area for push technology: semi-structured decisions require from systems to offer a wide range of models and data flexibility, but these requirements can be matched with modern push technologies[4].

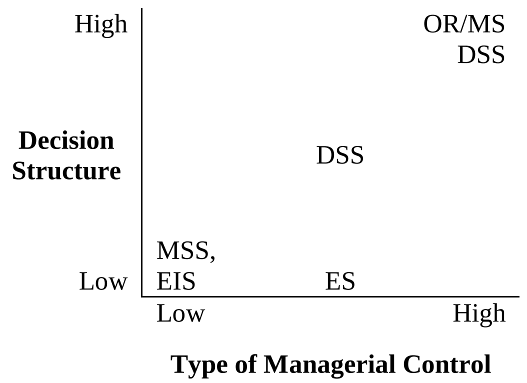

Figure 1. Decision Support Framework

We have identified the following features, which lead us to propose that push technology should be integrated in the DSS framework:

- Push technology can be both data and model – oriented: as we argued earlier, this technology has been used essentially for data and information retrievals, but various models can also be pushed to the users.
- Push technology provides support to decision makers: the definition of DSS as "… a computer-based information system that affects or is intended to affect how people make decisions" (Silver, 1991) indicates that the push concept fits by providing accurate and timely information and models needed to analyze this information.
- Push technology can support repetitive and *ad hoc* decisions: although the nature of push technology seems more appropriate to support routine decisions, a powerful combination with intelligent agents could

browsers, push clients, newsreaders, …) which could not be used in any convenient way.

[3] MSS understood as "a collection of computerized technologies whose objective is to support managerial work and especially decision-making"

[4] New push technologies enable to transfer software applications (and therefore models). The combination with intelligent agents can also provide push technology with the possibility to recommend models to users, and automatically integrate data into the model chosen.

help bring the push concept for ad hoc decisions which require intelligence.

- Push technology provides interactivity with the user: push technology is seen as an instrument for the decision maker. Therefore, he/she should be able to interact with the technology and not to undergo the flow of information.

4. Case study

In the following sections, we will show an example for application of push technology on a real case, in the context of Internal Logistics and Material Flow control where users have to make repetitive decisions. We will also show some preliminary results achieved with this implementation.

4.1 Description of the case company

The case company is the manufacturing plant of an electronics appliances company, producing over 400,000 television sets per year and employing about 700 persons. The manufacturing plant is known for the quality of its range of products, skilled personnel and experience in production for more than 40 years. The plant manufactures 20% of TV sets sold in the Nordic countries for a sales income of about FIM 1 billion.

4.2 Internal Logistics and Material Flow Control

The notion of Internal Logistics is understood as the process of ”delivering” to the right internal customer the right material (both in quantity and quality) at the right time (Coyle, 1996). This process is becoming a more and more complex issue to handle for many reasons: (i) companies need to reduce their own inventories due to cost pressures, (ii) production processes are themselves very complex: the material flow related to these processes can involve thousands of components (e.g. electronics manufacturing processes), (iii) for some consumer products, demand variations are very sensitive and internal logistics should be able to adapt to them, (iv) there is increased competition between suppliers for some specific material: this competition is often based on price, quality and timely delivery factors. Also, the scope of logistics and its impacts are becoming broader along the value chain, as managers should take into account complex phenomena such as the Bullwhip effect for example (Lee et al, 1997; Carlsson, 1999).

Managers who are responsible for material flow control often have problems to handle this complexity as they are squeezed up- and downstream in an environment where they can have little influence on ”external” factors. Consequences of this environment are that managers and logistics personnel are often spending their time ”fire-fighting” in order to: (i) find out what material is urgently needed and how to deliver it, (ii) ensure the continuity of the production process, (iii) make sure that the right material has been ordered at the supplier and (iv) run these operations efficiently. This type of environment is characterized by important flows of information whose relevance for managerial tasks is crucial to question. In fact, we should ask what is important to know and when? It appears that there is a lot of data available (as these processes are IT-supported), but it is difficult to extract and present it to the manager in a usable form.

There are many ways to influence positively and improve the management of internal logistics: these range from physical plant layout design improvements to modern inventory management methods. Many of them have appeared in the 1980s to support the organization and bring solutions to some of the problems that we have mentioned above (Just-In-Time, KANBAN, Zero Inventories, Management Requirements Planning), often implemented in the context of Total Quality Management programs. These methods are also supported by IT solutions. However, it seems that modern IT advances (EDI, data warehouse, Web- and push technologies) enable us to achieve better control of internal logistics.

The context of the internal logistics operations at our case company is described as follows: the production is organized in a modular way and reaches 400,000 units per annum with about 200 different product versions; the production is made in small series according to the market demands, hence requiring high flexibility both in production and logistics processes. Especially in logistics, coordination with suppliers and sub-contractors is crucial to keep low inventories and ensure continuation of the production process, as a stop in this production process usually has huge consequences on productivity. There is a distinction made between large and small components (cathode-ray tubes, speakers vs. electronics and chips).

The development of our support system is the result of a business process reengineering project taking place in our case company. The company has redesigned its internal logistics process through three main activities: (1) redesign of manufacturing plant layout, (2) tighter integration with the suppliers through a Web-based system, (3) implementation of a management control system and a data warehouse. The plant layout redesign was completed according to two principles: (i) minimization of components’ transport operations within the plant and (ii) separation of large vs. small components. The second and third steps were conducted jointly: a new production management and control system has been taken into use and suppliers have been given access to the system through a Web-based interface. This solution supports the management needs for better control of logistics information (amount of daily material use, availability, costs, status of incoming orders, …). This information is fed into a data warehouse to provide the manager with timely information and reports. The role of our support system in this development process was designed to improve the extraction from the data warehouse and other systems and presentation of time-sensitive data to the managers.

4.3 A support system for internal logistics and material flow control

Support system description: The support system is called Ticker: this is a software application, which scans one or more data sources on a scheduled basis and displays it to the user in form of scrolling information in a banner (as for sports results or stock's prices). The banner can run as a screen background or as a stand-alone application (Figure 2). The user himself can determine the information shown in the Ticker. The Ticker can use various color patterns depending on the nature of the information (e.g. blinking red means that the nature of the information is "urgent"). The interface uses the concept of hyper-text technology: that is clicking on a specific piece of information on the Ticker triggers a function which will retrieve background data related to that information (data, which can be extracted from many databases) and eventually prepare that data according to a "decision model", so that the user can immediately react and do not need to browse further for information. The decision model is a representation of the information, which is needed by the decision-maker in order to act on the problem at hands.

Ticker implementation cases: the Ticker has been developed for two cases, we introduce here shortly case 1 and present more thoroughly case 2, whose technical design is presented in figure 2:

- Productivity indices: a set of performance measures is specified and acceptance intervals are defined so that the user can easily observe variations of performance through the color coding in use.
- Scanning of order-specific information: the Ticker looks at the status of orders made to the suppliers. Let us take an example: managers need to be quickly alerted of orders' status (ordered, confirmed, delivered, …) in order to take needed corrective actions, as possible delivery delays can interrupt the production process. The nature of the decision process is repetitive as there can be dozens of incoming orders to follow-up each day. Also, the nature of the information needed to take a decision about an order is well known, but this information may be difficult to extract. The use of the Ticker comes from the facts that the software looks at order status in the database and checks that they are filled on time; if this is not the case, the Ticker uses color patterns to alert the user (green, yellow, red). When an order is clicked, a pop-up window, which we also call the "decision model", appears and displays all information related to that order (as specified in the decision model). Several functions are at that stage available for the decision-maker: drill-down in the data, export to other tools, e-mail forwarding, …

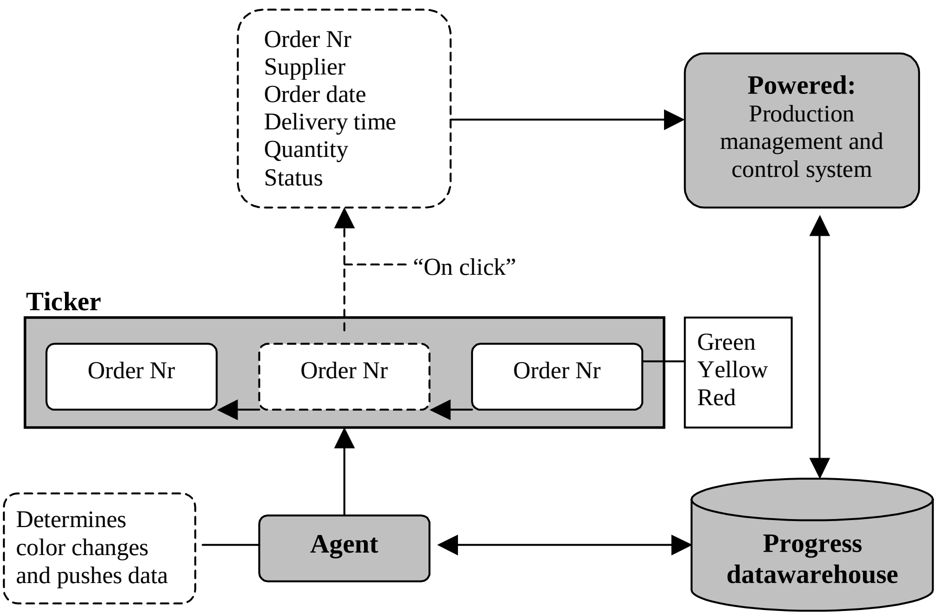

Figure 2: the Ticker integrated with the Management Control System

4.4 Results

The results presented in this section have been collected through interviews with 2 users of the Ticker. Therefore, the nature of the results is very qualitative. Moreover, we could not evaluate in very precise quantitative terms the effects of the system on the frequency, timing and duration of the interruptions: although many methods exist to collect data about work behavior (agenda methods, for example), we thought that the statistical description on the basis of a sample of two users would not contribute much more to the evaluation of the impacts of the Ticker. The position of the users are: Production manager and Manager responsible for Material stock.

The Ticker was expected to have an impact on FWT and improve the productivity of decision-makers. One of the key issues in our definition of FWT was the amount, frequency, timing and duration of work-related interruptions. In this respect, we have observed that the Ticker does not necessarily decrease the frequency of interruptions related to internal logistics problems; actually the number of interruptions may have increased because the Ticker is running as a background application on the desktop of the users and they constantly keep an eye on its status. It also appears that the frequency of interruptions increases. Concerning the duration of interruptions, we observe that it has been reduced. This may be better explained with the following example: the user may need to check the status of orders very often every day through the Ticker (this increases the number of tasks), but as the Ticker provides actual data, the user can identify problems at an early stage and take corrective actions before the impacts of the problems are amplified; typically, correcting a problem at an early stage should take less time: the decision model extracts and prepares the data that the user needs, therefore reducing the time needed to take any decision. In fact, we changed the nature of interruptions: we have enhanced the ability of the decision-maker to be proactive and avoid disruptions of stock inventories and production processes. This turns into increased productivity for the company.

When asked about their opinions about the reasons that the users see regarding improvements in the process, they identify (i) availability of information, (ii) usefulness of information and (iii) ease of use of the system. Accuracy of the information was not seen as an area where improvements could be identified. Also, managers confirmed that some of the routines related to the logistics were easier to handle due to the implementation of the management control system and that it generated less workload. A careful analysis of the company's productivity measures could help us to identify in which manner the process has been improved.

We have also learned that we should be careful about the presentation of information in push technology applications: it is important to avoid overloading the user with information, which is not needed. It is also important to make sure that the information is usable (possibility to forward, analyze, …), and that the user is not just overwhelmed by a constant flow of information (especially with a scrolling interface like in the Ticker).

5. Conclusion

This paper presents an implementation of push technology to the DSS framework. In particular, it illustrates how push technology suits to support decisions, which are repetitive by nature. In this case, the data sources and the information needs of the decision-maker are well known.

Our work was motivated by the implementation of innovative IT solutions in order to reduce Fragmentation of Working Time, which has been defined as the consequences of interrupted work environments and information overload. In this respect, interviews with users have revealed that interruptions have not decreased, but their changed timing allows to act proactively about emergent problems. Indeed, push technology and intelligent agents enable to identify emergent problems from large data sources earlier and to provide the user with the needed information.

Further work should focus on the implementation of push technology for supporting decisions, which are "ill-structured": these types of decision include strategic and financial planning, negotiations, loan approvals … Also, it would be interesting to provide more flexibility to the "decision models" that we use in the Ticker: the current decision model is generic and is common to all information included in the Ticker, we could, for example, try to vary the decision models according to the type of information of the Ticker. Research challenges in this area also include providing the technology with intelligent features in order to identify appropriate data and models and to combine them properly.

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